Braking Points
The Technology of Stopping Through the Years
As part of the growing number of Computer-Based Training Courses that NEIEP offers, Testing Hydraulic Elevators is the most recent addition to the Continuing Education Series. To stay competitive in the industry, it becomes imperative that elevator mechanics stay up-to-date with new trends and maintain their acuity on familiar ground.

This unit is meant to be used by those with previous instruction in NEIEP Year 3 material and experience in the field. A good understanding of safe inspection procedures and hydraulic systems is necessary before attempting tests that push them close to their limits. It may not be apparent that an unsafe condition is developing. Experience, common sense and the foresight to predict the consequences of your actions are required.

Excerpt from the text:
None of the duties performed by elevator maintenance and service personnel is more demanding of responsible and thorough inspection than the required periodic testing of critical components dictated in ASME A17.1 elevator codes. These rules are precise in the procedures to be followed for good reasons.

The elevator mechanic performing and reporting results of these operations bears the responsibility for the complete and careful assessment of the integrity of the equipment under test. The A17.1 rules pertaining to hydraulic elevators contain the minimum requirements but the manufacturer of specific equipment or your company’s policies may require you to include more tests than are mentioned in them. Furthermore these types of tests place equipment under stresses beyond those of normal everyday elevator operation. Following the guidelines in these pages insures proper testing and can reduce injuries and equipment damage that can result.

Instructions to access the Testing Hydraulic Elevators course:

- Log in to the NEIEP website www.neiep.org.
- On the home page, click on the “Online Training and Licensing” link located in the yellow box.
- Click on the “Continuing Education Courses” link.
- Click on the “Register” button of the appropriate course you would like to take.

If you have questions, please contact NEIEP at 800.228.8220 or email support@neiep.org.
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**Photography provided by:**  
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Chuck Lucas, Local 2  
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As with any helper, and now apprentices, entering the trade over the years, I had the opportunity to work with a number of mechanics who left me with experiences that I would or maybe wouldn’t use when I became a mechanic. One mechanic in particular that I had the pleasure to work with in Boston by the name of Don Campbell took the time to explain to me the importance of proper brake operation. He would schedule brake annuals for the gearless machines as part of a ride quality maintenance routine. We completely broke down all the mechanical components of the brake, cleaned them and re-assembled the brake. He took the time to explain the importance of checking the pins for wear, the shoes for buildup of dirt and grease that may cause them to stick to the drum when picking, and many other aspects of the mechanical components. He explained that smooth brake operation made for a smooth start. We then went through the electrical and mechanical adjustments for re-leveling and stretch of cable leveling which was particularly important for the high rise and freight cars.

When I became a mechanic, those lessons remained with me as well as some of the unfortunate stories that were told about individuals that did not fully understand the important steps of working on elevator brakes. This issue is intended to focus on various brakes and their use in our industry. As with any piece of equipment, take the time to be aware of your work environment and gather the necessary tools, parts, and help needed to complete the job professionally and safely. Always keep in mind that if you are unsure about something, ask for help. The safety of you, your co-workers and the public is your responsibility.

This publication would not be possible without the important and valuable contribution of knowledge each of the article authors have provided to all of us. Elevator constructors like you provide us with a firsthand perspective and experience that we all learn from. If you would like to share your knowledge in upcoming publications give us a call or drop us a note.

Work safe,

John J. O’Donnell
National Director
Probably one of the last things we worry about on the elevator installation is brakes. To an elevator mechanic this simple term applies only to the device mounted to the machine or bedplate. In a modern elevator it has the simple normal function of holding the machine from rotating and the car at the floor during loading and unloading. In these modern types the car is slowed and stopped electrically by the motor control circuits. Some brakes apply several inches from the floor and allow the car to slide that distance and stop near the floor. Fortunately these types are being modernized at a fairly quick rate. “What about an emergency stop?” you might ask. That’s a good question because now we’re asking the brake to do some real work like brakes on a truck going down the highway. The more total weight or weight differential between car and counterweight, the more work needs to be done to stop it. Even an empty car traveling up requires a tremendous amount of stopping power. The inertia of even a balanced car is a tough job to bring to a stop, not to mention the ultimate full load down situation.

Once the total suspended weight of an elevator system is in motion, stopping it is not an easy task. Speed and load are the only other variables, or are they? Let’s take a look at a situation that may be similar to something you’ve already seen. A car in a 20 story building running at 500 ft/min starts running in the middle of the night. Instead of slowing down and stopping at each floor, it makes a high speed stop when it should be going into slowdown. Since it never makes it into a floor to call home, it keeps running looking for one. In an hour or two the brake gets pretty hot but the car keeps running. To make matters worse the brake drum starts to expand from heat, reducing clearance to the shoes. The shoes soon begin to drag even with the brake energized, making them hotter. What happens next, if some kind of error does not stop the car or someone does not shut it down, is similar to what would happen to your automobile driving down a long steep winding road. The brakes fade and eventually they can’t hold their intended load. Even a car with no load may be too much for the brake to hold and you know what happens next. Just hope you’re lucky enough not to be in the machine room when the car comes up to greet you.

Sure this is a little farfetched but it demonstrates how things change with extreme heat. Engineers who design brake systems are well aware of these worst case scenarios and design brakes with enough mass and area to
shake off heat and prevent a catastrophe. So what’s to worry about, you say? What if when the brake shoes were set up they were not correctly seated for full contact and only the corners or edges of each shoe is making contact to the brake drum or disc? Even though you placed 125% load on the car and made sure it held and stopped reasonably well from high speed, there’s still a problem. Sometimes what appears proper may not be. The pounds per square inch of brake pressure is probably close to where it would be if the contact were distributed along the entire shoe, so the car stops and holds full load as normal for the test. Heat does not have the area it needs to escape and the corners or edges of the shoes heat and fade fast and you know the rest. A well designed brake can fail if the installation or maintenance procedures are lacking. The only thing that a well designed brake does not do is to tell you the endless possibilities of things that could go wrong if it is not followed to the letter. After an elevator accident the finger always points somewhere. Don’t let it be in your direction. Don’t skip steps, don’t take shortcuts, be confident in your understanding of the task, and perform it professionally.

**BRAKE COMPONENTS**

Elevator brake systems are made up of friction surfaces and the means to move them at a somewhat controlled rate. Many methods have been successfully used to accomplish this but the drum brake system has been the most popular for over a hundred years. Common components of the drum brake system are mentioned here as well as the disc brake system, which is gaining in popularity.

**Brake Shoes**

Nearly all brake shoe material contained asbestos prior to the 1980s, before the use of this carcinogenic material was abandoned. Despite its significant health risks, asbestos had a good coefficient of friction over a wide temperature range along with great wear qualities. Modern brake lining material is a composition of glass fiber, mineral fillers, and metal particles molded in a high temperature resin. Most modern brake lining are bonded with adhesives to the brake shoe but in some cases riveting is also used.

New brake shoes must always be checked for proper seating to the brake drum. A high spot in the lining will become a hot spot in operation and also prevent the entire shoe area from sinking away heat. A poorly seated shoe may appear to hold the required 125% capacity load just fine but may fail under high heat conditions. New shoes should be installed and operated in inspection mode making frequent stops and starts and then checked for surface contact. High spots will be apparent when the surface is inspected and should be sanded, filed, or scraped to remove them. This process requires wearing an approved breathing apparatus. Repeat this until near full contact is achieved. Some shoes are self aligning to the drum and others require careful adjustment before locking them in position.

**Springs**

When you look at a drum brake or even some disc brakes, what catches your eye first are the springs. If you think about it a coil spring seems like too ancient of a technology to play such an important part of a modern elevator. We trust it to hold the same tension over its lifetime without weakening from compression. When it is set up to hold 125% load required by A17.1 code we assume that it will stay that way for at least five years. It is manufactured under tight tolerances and carefully tempered to assure that the characteristics don't change.
We even disassemble the brake and reassemble it using the length of the compressed spring as a guide to adjust it exactly as it was originally setup. But what else can go wrong? Anyone who has ever set up a brake to hold 125% load knows what increasing or decreasing the tension even a small amount can do. It’s a fine line and it’s best to err on the side of caution by taking up a little extra on the springs. If the spring is too tight the brake becomes difficult to control. The pick and set may be slower or faster than desired, producing noise and abrupt starts and stops. It’s no mystery what happens if it’s too light on tension. Take for example the earlier mentioned brake shoe that is not properly seated. All appears well in a 125% test and even a high speed stop or two. The down side is that the high corner on the shoe wears quickly and the whole brake arm moves closer to the drum as it wears. A small amount of wear at the shoe is translated to double that movement at the spring and tension is reduced far more than expected. Even if you happen to make that critical adjustment when the brake drum is warm its diameter will reduce when it cools and spring tension could become less.

The primary job of elevator brakes isn’t to bring the car to a smooth stop from high speed but they do a pretty good job of it. One thing that you don’t want to happen is to have a brake so tight that when it is applied at high speeds, the cables break traction with the car sliding several floors before coming to rest. Losing traction in this type of emergency situation isn’t completely bad but it shouldn’t be excessive. Many types of fancy circuits have been tried to apply brakes in an emergency or power failure without excessive loss of traction and to obtain the shortest reasonable stop. These circuits include using CEMF to sustain motor field strength and regeneration to help slow the car. These circuits can be adjusted for a good high speed stop on any given day but it will usually change tomorrow when it’s colder or raining outside. The one thing we cannot change is the traction relationship.

Greatly simplified, traction limits are such that cables will slip anytime an empty or fully loaded car is decelerated or accelerated at about two or three times its normal contract rate. A car that is making a terminal slowdown, or worse yet, an emergency terminal slowdown, is pushing traction to near its limits. We know that a normal up stop makes us feel pretty light on our feet, and the same stop in the down direction slides our lunch a few inches lower. This is exactly the effect that makes the counterweights heavier and the car lighter as in the case of an up stop during the seconds of deceleration. The ratio of car weight to counterweight weight drastically changes in extreme cases and traction is lost until all comes to rest. How far is that, you ask? Nobody knows. Well at least nobody knows exactly. You can bet though that it is plenty enough to slam a buffer. A rated speed 125% stopping distance test may not be required in periodic testing, but you should be confident that there is enough spring pressure and traction to achieve it.
Adding cab components to a platform is a good example of a situation where traction or brake holding power can be lost. Most mechanics realize that the weight of the car and the weight of the counterweight must be kept fairly close to equal during construction to avoid loss of traction. You may have even ridden on a platform during construction that seemed to slide too much on a brake set only to find out that the hard brake on inspection initiated a brief loss of traction. On a fully completed and balanced car the ratio of car weight to counterweight weight does not exceed about 1.8 to 1. This weight ratio is never exceeded from empty car through full load. If this ratio is exceeded the risk of traction loss is great. On a construction platform the car and the counterweight are not at their completed weight and this critical ratio is much lower. To make matters worse compensation may not be in place. Keep a constant vigil during construction to maintain the weight of each at near equal and never try to carry heavy loads at this stage of construction. The same applies for removing cab components during a modernization. Don’t skip steps. Remove counterweight or add weight to the platform as you remove cab components. If you are experiencing substantial differences in the amount of brake slide in each direction, consider it as a warning that balance needs attention.

**Brake Coil and Core or Solenoid**

Brake solenoids provide the movement to lift the shoes from the brake drum or disc. Large DC brake coils are slow to respond to applied current due to their inductance. The larger the brake coil, the more time is necessary for the magnetic field to build. This is not a bad thing because it allows for a slow smooth brake release. Smaller brake coils are quick acting by comparison and therefore not too much control can be achieved with electrical adjustment. The amount of built in inductance in the brake coil and core or plunger are pretty much dependent on their size, which determines the amount of copper and iron that add to their inductance. The size and time relationship also holds true for the amount of time the brake can be delayed for a soft set.
Core or plunger travel inside the coil is usually less than ¼ inch, with each machine having a manufacturer-preferred amount of travel. The iron core slides inside a stationary bronze or steel sleeve that the coil is mounted around. In most cases the core and sleeve must be disassembled for lubrication purposes on an annual basis. There are a few types that require no annual lubrication due to the composition of the sleeve and core. The core of these types should never be lubricated.

**Brake Switches**

Switches mounted to the brake system send signals to the controller that can be used for a variety of reasons. The simplest operation is to add series resistance to the brake coil once it is fully released. This resistance lowers the voltage to the coil from its original applied higher pick up voltage to only enough to hold the brake in its released position. This voltage reduction can be substantial, sometimes as much as 40%. This reduces the heat of the coil and extends its life. Other types of control may use this signal to initiate the application of power to the hoist motor to start the car. Adjustment may be critical here to assure a smooth car start. Most modern systems include the function of detecting that the brake is actually picked and generating an error if the signal is not seen.

The movement in all parts of most brake systems is slight which can make this adjustment difficult. Add to this the fact that the operating points can change with heat and it can become a source of unexplained shut-downs. This movement is usually detected at the brake core or plunger where travel is greatest. The even less available movement of disc brake components can present a real challenge for proper adjustment. Switches can be heavy carbon and copper contacts or simple micro-switches depending on the current demands. A safe place for an initial adjustment is half of the travel distance of the core but many systems will require operation much closer to the full released position for best operation. Intermittent failures of these switches can trigger all sorts of seemingly unrelated errors. Include the careful inspection of these switches during inspections and when looking for the source of intermittent system generated errors.

**Brake Arms and Pivots**

The brake shoes are held in precise alignment with the brake drum by the brake arms on conventional geared and gearless machines. They translate the slight motion
of the brake core to an even smaller motion to raise the shoes mounted near the center of the arms from the drum. This distance may be only a few thousandths of an inch and on some brakes the motion is difficult to detect with the eye. The arms usually pivot at the bottom on a steel pin and motion from the core is applied near the spring at the top through a lever arm. There is only a fraction of a degree of rotation at the bottom pin, yet it can become a source of problems if it is not lubricated regularly. This minute amount of movement sets this area up for the same type fretting corrosion (rouging) that occurs in a dry hoist rope from the flexing it sustains as it passes over a sheave. In extreme cases the pin can freeze to the arm and lock it up as if it is welded to the bedplate or frame.

Mechanics have seen the condition where the shoes were lifting from the drum by the powerful action of the core actually bending the brake arm to lift the shoe. Electrical adjustments can sometimes make things appear to be correct when they are not. When an empty car is mysteriously found in the overhead a bind in the brake hardware should be suspected. The expression that a well placed drop of oil prevents a multitude of problems couldn't be truer than on brake pins. Brake pins should be checked for freedom by tapping their ends with a hammer on each end and rotating them. Care must be taken not to mushroom the ends of the pins. It's not a bad idea to bevel the ends of brake pins so that slight mushrooming does not make them difficult to remove. There is no substitution for an annual brake job that requires disassembly, cleaning and lubrication.

Disc Brakes

Brake Solenoid and pivot arm apply lifting force to brake arm and shoe.
Gone are the days when a skilled elevator operator came to a level stop by applying the brake several feet from the floor and coasting to a landing. Enter the days of operating efficiency and lower production costs through the use of modern technology. Present day control systems bring the car to an accurate stop at the floor electrically without the need for a large mechanical brake system. For this reason the massive conventional elevator brake is being phased out and replaced with the capable low mass disc brake systems.

The amount of energy required to accelerate and decelerate a huge rotating drum style brake weighing several hundred pounds is greatly reduced with a disc brake. Low inertia disc brake systems save a substantial amount of energy that translate into lower operation and production costs. Low mass systems require less horsepower to get the load rolling. This is apparent in the smaller, faster-responding door operator motors in modern systems. Low inertia motors have reduced diameter which lowers inertia of the rotating mass and provides speed changes with less effort. Quick responding elevator control systems can smooth out speed changes that in the past required the added mass of iron and copper in the motor and the massive brake drum to duplicate.

Besides providing a low mass solution disc brakes have an added advantage in code compliance. The recent code requirement to have a separate and independent brake system is easily fulfilled. A second caliper and brake shoes can be added to act on the same disc to satisfy code requirements.

Disc brakes are one of two general varieties. The most common in later installations is the caliper type. The caliper type uses two friction pads that pinch the disc evenly from either side similar to automotive disc brakes. The disc is rigidly mounted to and spins with the motor or machine shaft. The caliper assembly is stationary, usually fixed to the machine. The added advantage of this type is that the caliper is small enough to allow mounting of a second caliper and friction pads to act on the same disc. This dual caliper arrangement meets the recent code-requirements for a second independent...
brake system. The second type popular in some installations uses a circular friction plate with a braking surface on both sides. The friction plate is sandwiched between two pressure plates similar to an automotive clutch. One of the pressure plates is moved away from the friction disc via electromagnets to release the brake. The friction disc is free to move a small amount on a splined portion of the motor shaft so that it can center between the two pressure plates to reduce drag when lifted. One advantage of this type is that the friction surface area is greatly increased over that of the caliper type.

It's true that a disc brake would not be as reliable as a drum brake for the rigorous frequent brake stops required of older equipment. However, with that need long gone and considerations of all of the other savings provided with disc brakes, drum brakes will become rarer on new equipment. In spite of the trend to use disc brakes some manufacturers still prefer the venerable drum brake on their new equipment. Its reputation for over one hundred years is commendable. It would be hard to imagine that disc brakes could enjoy the service life afforded by the time and duty proven drum brake.

Regardless of the type of brake used on an installation the maintenance Mechanic is the person who needs to determine whether operation is satisfactory. Careful inspection is required during each maintenance stop. Noise, heat and freedom of moving parts should be given attention. These areas are very familiar to the seasoned Mechanic especially on equipment that has been around for years and may have developed their own warning signs that signal him a need for service. This is a luxury that may not be afforded by the new types of brakes appearing on modern equipment. Get into the habit of closely inspecting and understanding the operation of these newer style brake systems. Nobody in this business likes surprises and finding a car in the overhead for no apparent reason is one of those. A critical eye during inspections can keep things running smoothly.
Get a Grip on Your Profession: Get Involved in Mentoring

By Fred Yaniga Jr., Ph.D.
Butler University
Indianapolis, Indiana

IF YOU ARE NOT INVOLVED IN MENTORING, YOU SHOULD BE!
If you are not involved in some kind of on-the-job mentoring relationship today, you probably should be. Both formal and informal mentoring is one of the newest trends today for maintaining a smooth transition of knowledge and skill from one generation to the next and for ensuring the promotion of sound teamwork principals while building true pride in the profession.

“Mentoring gives structure to the centuries old practice of passing on information and integrating new practices while building a commitment and dedication to the profession from which both the employees and the industry as a whole can benefit.”

The days of the Leonardo da Vinci and the Renaissance Man are long over. Our work world has become too complex for any one person to be proficient in all aspects of the job. Computer programmers once enjoyed the last bastion of the isolated worker while spending long hours writing code in mom’s basement. Now, even they find themselves more and more integrated into work teams. Work on these intricate projects is often performed within a team whose members offer a sounding board for ideas, criticism and encouragement and improve the product by working together throughout the development process. The elevator industry is certainly no different in its complexity and a quick review of the articles in this edition of LIFT shows how varied and intricate the elevator braking components alone can be. It is unlikely that you will find any one person who has detailed knowledge of all of these systems, but certainly you will find a handful of mechanics in your local who are known as experts on one or the other, probably because they have worked on those systems for years.

This is where mentoring comes in. That knowledge, developed by years of experience, needs to be passed.
along and shared. At the same time, newer ideas and information often come from below and must find a path for integration in the field. Apprentices finishing their training program are still just beginning their careers in the field, and older colleagues can profit from their energy and perspective. Mentoring gives structure to the centuries old practice of passing on information and integrating new practices while building a commitment and dedication to the profession from which both the employees and the industry as a whole can benefit.

WHAT DOES A MENTORING RELATIONSHIP LOOK LIKE?
Mentoring programs are the hottest trend in industry and education today, but there are many different models and approaches for establishing a mentoring program. Some industries, like the bricklayers, have formalized the mentoring process and have organized structures for pairing mentors and mentees as well as for evaluating the relationship and determining how long it should continue. Other industries allow mentoring relationships to grow organically without imposed structures. As a kid, I tagged along on many a work-day to Slyman’s deli on the near east-side of Cleveland where elevator mechanics met in the morning over a quick breakfast and “talked shop.” Those quick and informal get-togethers certainly were the platform for a lot of informal learning and the cultivation of mentoring relationships. Such laid-back settings often present the perfect opportunity for questions to be asked and for the ice to be broken. Those S.O.S. calls later in the day on the radio were more easily made between two workers who had shared a cup of coffee that same morning. In fact, mentoring relationships can often begin informally and casually and develop over time. Once the mentor and mentee realize that they work well together and trust and appreciate each other’s advice and company, their relationship can grow naturally and without a formal structure.

But mentoring must always be thought of as a two-way street. Both the mentee and the mentor should benefit in order for the relationship to remain productive over time. The mentor obviously provides know-how and experience from an accumulated career. But the mentee does not come to the table empty-handed. The fresh perspective and questions a mentee can bring should invigorate the more experienced colleague. Often, that younger mentee may be involved in training programs in which new technologies are being introduced. Here, the mentor and the mentee have valuable common ground on which they can learn from each other while also building the trust and confidence necessary to make the mentoring successful.

WHY SHOULD YOU BECOME A MENTEE?
Mentoring can take place in both formal and informal settings.

A mentoring relationship may be your key to some of the most valuable learning and advice you will ever receive on the job. Those co-workers who have been in the field for many years probably know something you will need to learn if you hope to be successful, and if you can cultivate a relationship with them, your learning curve
will be a lot smoother than the old-fashioned trial-and-error method. At the very least, these older co-workers probably know exactly who to call in a pinch and who to contact when things get rough. They can give invaluable advice about how to get things done on certain jobs and how to navigate the bureaucracy of the office. More importantly, if you find the right mentor, you might find a friend and colleague who can offer advice, fair criticism and encouragement throughout the vital years of your career development. Having a mentor who is not your immediate supervisor might allow you to ask questions in confidence about job-related situations and get input on ideas before putting your foot in your mouth in front of the boss later on.

**HOW TO BE A GOOD MENTEE**

Being a good mentee starts at the very beginning: whom do you choose as a mentor? Be careful. Not all successful co-workers will be your best mentors. Look for someone with whom you get along and who shares your interests and appreciates your challenges. Look also for a mentor who takes time to help you and follows up on problems you have discussed together. A mentor too busy with his own problems won’t be of much use to you. Also beware of expecting too much from a mentor. Mentors are not there to solve every problem and they may not want to extend the relationship beyond the workplace. But mentors who can offer sound advice and who are willing to talk with you about job-specific issues and scenarios from time to time might be more valuable to you professionally than any workplace “friend.” Accept the limitations of the relationship and look to foster it by honoring the mentor's time. With good communication and a positive attitude toward the learning experience you will find that many experienced co-workers will be happy to share their knowledge and experience with you.

**ADVANTAGES FOR MENTORS ALSO**

Older co-workers sometimes express fear over passing along too much of their know-how and skill to the younger generation. Their concern is that they may be teaching themselves out of a job. But the fact is this teaching capacity is exactly what the industry needs from more experienced workers. Without strong continuity in the skills of the trade, the entire industry suffers and becomes top-heavy. What happens when the older workers retire and take their skill and know-how with them? If the younger generation has not been properly initiated and guided along, they will be far less productive and less able to carry on at the same level of quality and efficiency.

*Mentoring relationships offer benefits for the mentee, mentor, and the industry as a whole.*

But it is not only a question of what happens to the industry after one knowledgeable and capable generation moves on. Before retirement is even on the table, more experienced workers can benefit from mentoring relationships with younger colleagues. One Indianapolis-based Tae Kwon Do Grandmaster tells the story of how he has had his black belt so long that it is beginning to turn white (beginner's level) again. Indeed, that old black belt is fraying and the white insides are showing, but that is not what he means. He calls this philosophy “Cho Sim” which in Korean means “Beginners Mind.” The lesson is that even experts need to keep learning and improving, to occasionally look at tasks from a beginner's perspective and rediscover their profession by tapping into that beginner’s curiosity and ambition. This might be a lesson in

*Black belts practice alongside beginners. “Beginner’s Mind” means never assuming you have learned everything there is to know about your profession.*
humility for long-time mechanics, but a lesson that would serve anyone well to put into practice.

Mentoring offers older colleagues the opportunity to interact with younger apprentices and helpers who bring a fresh perspective to the profession. Not only do they ask questions which the seasoned pro may not have thought about for ages, they challenge preconceived ideas about best practices and force us to explain why performing a task in one way is better than another way. We all know that there is no better method of learning than having to teach. You must be absolutely positive about how something works before you can explain it well to someone else. But these fresh questions from an assistant or helper force us to reexamine the way we do things and the way we teach others to do them. The mentoring relationship forces us to keep that “Beginner’s Mind” which keeps our brains agile and active and helps keep us from slipping into complacency and habit.

ARE YOU A GOOD MENTOR?
The components of good mentoring are varied and in no way limited to the list below. Still, read through these suggestions and determine if you can improve your mentoring style by adopting some of these ideas:

- Be generous with your time. A five or ten minute conversation might not seem like much to you, but it could make a world of difference to a young apprentice with a problem.
- Offer honest guidance and criticism without sugar-coating. By the same token, offer praise and encouragement where they are deserved and needed.
- Avoid abusing your relationship by having unnecessary or inappropriate expectations. Many mentees will do just about anything to stay on your good side. But avoid the temptation to use them exclusively as your personal coffee-fetcher.
- Look for opportunities to teach AND learn together with your mentee. As with the method Socrates is said to have perfected, remember to direct the mentee to answers by asking guiding questions rather than offering answers immediately and show honest interest in your mentee’s projects.
- Try to learn yourself from new developments in the industry and have your mentee share with you what he is learning. Keep that “Beginner’s Mind” by going out and checking out the latest improvements and discussing them with your mentee.

MENTORING AS THE BACKBONE OF OUR INDUSTRY
Whether you are involved in a formal or informal mentoring relationship, remember that the efforts you put into that partnership are valuable not only for the mentee and for yourself, but also for the industry as a whole. As new recruits enter the occupation, they want nothing more than to be involved, to continue learning, and for their work to be valued. Mentoring is one way of truly offering new recruits the possibility of connecting with colleagues who can help them along that path. Mentees who feel they are constantly improving their skills and learning new things while offering a valuable contribution to the team are more likely to stay motivated and remain in the program. An educated, motivated and skilled co-worker is a profound benefit for his colleagues, his company, his union and for the industry as a whole. As I wrote in the 2007 issue of LIFT, elevator technicians are true craftsmen, and this is a craft which deserves to be passed on with attentiveness and pride. A young co-worker and a recent retiree share the same feelings of pride and accomplishment when they walk by a building and say to themselves, “I installed those elevators,” or “I did construction on that job,” or “I worked service and repair on those cars.” To ensure that this feeling of pride continues, mentoring must be taken seriously by both young and old, by new apprentices and experienced colleagues. Finishing the apprenticeship program is not the end of your education in the elevator trade, but just another beginning. Likewise, even if you have been a mechanic for decades you still have a lot to offer, and can still learn more on the way. So if you are already involved in a mentoring relationship, call up your mentee or mentor and check in. Have that cup of coffee soon. If you are not in a mentoring relationship, start looking for that person to connect with. Without doubt, you will benefit personally and professionally from a solid mentoring relationship whether you are just beginning in the business or have been in the field for many years already.
EMERGENCY BRAKES
A geared elevator traction machine shaft fails at a mid-rise office complex, and the integral connection between the gear box and the brake drum no longer exists. Since the counterweight is typically 40% heavier than empty car weight, the car accelerates uncontrolled, as expected in the up direction. The counterweight slams into the buffer and as the car continues up the hoistway the ropes go slack and the car jerks to a stop well below the top of the hoistway. The passenger in the car is shaken, luckily survives virtually unscathed.

A second scenario finds a young service mechanic receiving a report of an elevator moving up and down at the floor several inches in both directions with the doors open as passengers are entering and exiting the car. He arrives on the job and during the course of his investigation determines that the brake core is hung up and is not dropping after the car comes to a stop. After the initial shock, panic sets in, and the mechanic races over to the main line disconnect switch to remove the power. His face reveals a split second of relief as he averted a potential catastrophe. Just as the mechanic is wiping the sweat off his now grease-smeared forehead, he hears a whirring sound emanating from the machine as the ropes peel off around the drive sheave and the gear box roars to life. The mechanic snaps his head around glancing at the now de-energized disconnect switch to verify he turned the correct elevator off, just to be deafened and rattled by the awesome crash of the elevator molding itself into the top of the hoistway. As he cowers into the fetal position in the corner of the room he can’t help but notice the rope shackles attached to the car which now seem to be a permanent fixture protruding through the floor of the machine room.

In an instant this savvy, up and coming mechanic realizes just what went wrong. When the power was removed from the controller the elevator motor was no longer under control, and the bound up brake core left the car and counterweight at the mercy of earth’s natural law of gravity. The elevator races up the hoistway uncontrolled until it comes to an abrupt stop in the overhead with the safeties set.

In the late 1990s, over a five-year period, there were at least 18 documented cases of ascending elevators striking the overhead. In some cases, the accidents resulted in serious injuries or fatalities. These accidents occurred on counterweighted elevators as a result of electrical, mechanical, and structural failures.

Following are two examples of ascending car overspeed accidents that promulgated the rapid introduction of elevator codes designed to protect against these accidents. You will notice that there is a very short duration between when these accidents occurred and the adoption of new code regulations from both the American and Canadian authorities.

PENNSYLVANIA BUREAU OF DEEP MINE SAFETY
An ascending elevator car accident occurred at a western Pennsylvania coal mine on February 4, 1987, causing extensive structural damage and disabling the elevator for two months. Following this accident, the Pennsylvania Bureau of Deep Mine Safety established an...
advisory committee to research if there are devices that are available to provide ascending car overspeed protection for new and existing mine elevator installations.

The following four protective methods were determined to be feasible based on engineering principles or extensive mine testing:

1) **Weight balancing (counterweight equals the empty car weight)**
2) **Counterweight safeties**
3) **Dynamic braking**
4) **Rope brake**

The Pennsylvania Bureau of Deep Mine Safety approved these four methods and made ascending car overspeed protection mandatory on all existing counterweighted mine elevators within the state of Pennsylvania, effective December 1, 1991.

**CSA-B44 ELEVATOR SAFETY CODE**

Four days after the fatal Scotia Plaza construction elevator accident that occurred in Toronto on August 29, 1987, the Canadian Standards Association Executive Committee on Elevator Safety Codes began to consider the need for protection against the hazard of the car overspeeding into the overhead structure. The Canadian CSA-B44 Elevator Safety Code addressed the ascending car overspeed hazard with a three-page-long rule that went into effect April 1, 1990. The rule specified possible elevator components failures and defined the hazards that could be caused by failures such as free fall and overspeed in both directions. The rule also listed basic performance criteria for protective means to guard against the hazards, allowing application of new technologies without prohibiting the old designs.

The safety code also addressed the potential risk of injuries to passengers if a failure caused the car to leave the landing with the door open. This hazard could cause the passenger to be crushed between the car floor and landing door header, a risk which is also present in the down direction. To eliminate the “trapping risk” in both directions, additional protective means that detect any uncontrolled movement of the car are required.

There were three methods recommended as new or retrofit solutions for ascending car overspeed as a result of the Scotia Plaza and Pennsylvania mine accidents.

**COUNTERWEIGHT SAFETIES**

The customary method is to install traditional safeties on the counterweight; however, the reliability of this old technology is being questioned especially with maintaining this safety system under the less than desirable operating environment that is present in mine shafts. In addition, this method can be difficult to install on existing elevators, particularly if the counterweight guide rails and brackets need to be replaced to accommodate the additional load forces. Clearances may not be available for the counterweight safeties due to limited shaftway dimensions.

**DYNAMIC BRAKING**

A second solution used in the United States mining industry is the application of passive dynamic braking to the elevator drive motor. Most elevators use direct current drive motors that can perform as generators when lowering an overhauling load. Dynamic braking simply connects a resistive load across the motor armature to dissipate the electrical energy generated by the falling counterweight. The dynamic braking control can be designed to function when the main power is interrupted. Dynamic braking does not stop the elevator but limits the runaway speed in either direction; therefore, the buffers can safely stop the conveyance.

**ROPE BRAKE**

A pneumatic rope brake that grips the suspension ropes and stops the elevator during emergency conditions was developed by Bode Elevator. This rope brake has been used since August 12, 1957.

**Case Study: Rope Brake Testing and Evaluation**

The first pneumatic rope brake was installed in the United States at a western Pennsylvania coal mine on
September 8, 1989. The Bode rope brake (model 580) was installed on this coal mine elevator. This rope brake installation was tested extensively by Mine Safety and Health Administration engineers from the Pittsburgh Safety and Health Technology Center.

Since then, the elevator code authorities have adopted stringent requirements to protect against failures such as the imagined and real ones described previously. Many companies have developed elevator emergency brake devices, such as the sheave brake, rope gripper and dual machine brakes found on some of the modern Machine Room-Less elevators. These are meant to prevent the car from crashing into the overhead (ascending car overspeed) as well as to prevent the elevator from moving away from the floor with open doors (unintended car movement).

Although there are many requirements that an elevator emergency brake must conform to, its primary purpose is to protect against 1) ascending car overspeed and 2) unintended car movement with doors open. The applicable code rules for these are found in ASME A17.1/CSAB44 sections 2.19.1 and 2.19.2, respectively.

The emergency brake is a mechanical device independent of the braking system used to hold, retard, or stop an elevator. It applies should the car overspeed or move in an unintended manner. Such devices include those that apply braking force on one or more of the following:

(1) Car rails
(2) Counterweight rails
(3) Suspension or compensation ropes
(4) Drive sheaves
(5) Brake drums

The emergency brake is not to be used to provide the normal stopping of the car. Examples of devices that may be used as an emergency brake include:

(1) Counterweight safety

(2) Rope brake
(3) Sheave jammer (sheave brake), a device that acts on the drive sheave to stop the car movement
(4) Secondary brake, if the brake drum is directly connected to the drive sheave

These devices are intended to operate should the primary device fail. A single device may be provided for ascending car overspeed protection and unintended car movement or separate devices may be provided. A counterweight safety and governor could be used for ascending car overspeed but would not provide protection against unintended car movement in the down direction.

On some MRL elevators today there are two separate brakes, normal and emergency, that act on a braking surface integral to the drive sheave. Due to the inherent difficulty in maintaining these elevators with the machine mounted in the overhead of the hoistway, the use of rope grippers has made it a difficult scenario at best when servicing or manually overriding this safety device in the event of a power failure.

ASME 2000 BRAKING REQUIREMENTS

The ASME 2000 Code requires three forms of braking: a machine brake, an emergency brake, and a braking system (ASME, 2000).

Machine Brake

The requirements of the machine brake are as follows:

1. It must hold the car statically with 125% of full load.
2. It must be capable of decelerating an empty car traveling in the up direction at a maximum rate of 1G, the rate of a buffer.
3. The machine brake must have the thermal capacity to decelerate the empty car in the up direction based on an initial velocity that is the governor overspeed trip setting.

The machine brake does not need to stop the car in either direction and there is no minimum deceleration rate (ASME, 2000).
Emergency Brake
The purpose of the emergency brake is to deal with Ascending Car Overspeed and Unintended Car Movement, both of which are new requirements that appeared for the first time in the 2000 Edition of the ASME A17.1 Code (ASME, 2000).

Ascending Car Overspeed (ACO) and Unintended Car Movement (UCM) protection can be provided by one common device known as an emergency brake or by multiple devices (ASME, 2000). Devices that are permitted to provide this protection include sheave brakes, rope brakes, counterweight safeties, and bi-directional safeties.

The emergency brake required for ACO and UCM has a requirement that it should “not on its own cause the car average retardation to exceed 1G (9.8 m/s²)...during ascending car overspeed” (ASME, 2000). If other braking means such as dynamic braking or the machine brake are also employed, then decelerations in excess of 1G are acceptable. It is assumed that a person can withstand a vertical deceleration of 1G with deceleration transients greater than 1G and most codes apply such limits (ISO, 1990).

The emergency brake must function independently of the machine brake. This seems logical because the proximate cause of the unintended movement could be machine brake failure as realized by our savvy mechanic. One other requirement of the emergency brake is that it must limit the maximum movement after detection of unintended movement to 48 inches (1220mm). This could be detected when the car leaves the leveling zone with the hoistway door unlocked. The maximum leveling zone is 18 inches (450mm) above or below the floor (ASME, 2000). On a typical 7’ door opening there would be an opening of 18” remaining if the maximum 48” movement is reached.

Braking System
The braking system is defined as the “driving machine brake and in addition shall be permitted to include other braking means, such as electrically assisted braking” (ASME, 2000). The braking system can also include the emergency brake.

The braking system has four significant requirements:
1. It must be able to decelerate a car that is loaded to 125% of capacity in the down direction.
2. It must decelerate an empty car in the up direction.
3. The maximum deceleration rate is 9.8 m/s², with no presently defined minimum.
4. The braking system must have the thermal capacity to decelerate the car based on an initial velocity that is the governor tripping speed.

DOWN DIRECTION OVERSPEED PROTECTION
Elevator codes have come a long way to keep pace with the evolution of elevators as they change with the landscape of the cities. Every traction elevator, along with some other types of vertical transportation, is equipped with a stopping device for a car traveling in the down direction. This device is the safety gear typically mounted under the elevator and activated by a speed governor, which clamps the governor rope when the elevator overspeeds in the down direction. When the governor rope is clamped it engages the safety gear, which then contacts the guide rails to stop the elevator.

BIDIRECTIONAL SAFETIES
Until recently, elevator governors have been unidirectional, activating the car safeties when the elevator overspeeds in the down direction only. The development of a bidirectional elevator governor suggests the possibility of a bidirectional safety rather than two different safeties, one for unintended movement in each direction.

These devices work a lot like traditional down directional safeties, but are capable of deploying and grabbing the rails to stop the car – in both directions. Bidirectional safeties can be effective in protecting against ascending car overspeed, as they can be set using a traditional centrifugal governor or with the use of a bi-directional governor. Protection against unintended car movement is a little more difficult to accomplish with bidirectional
safeties. However, some newer designs do provide this protection with the use of a battery-backed-up solenoid to engage the governor even in the event of a power loss. This governor mounted solenoid can also be used as a remote set feature when mounted in the overhead on machine room-less (MRL) applications. This solenoid is used for test purposes only and is operated from the control room.

The bi-directional progressive type safety gear is effective in the up direction as well as in the down direction. The safety gears are installed below the car frame. When the overspeed governor reaches tripping speed during upward or downward movement the safety gear is engaged. The overspeed governor rope is clamped and pulls the safety lever up or down into brake position. Left and right safety gears linked by a connecting shaft will grip at the same time. The uniform set of both safety gears is essential and adjusted for good synchronization during installation. Once the safeties are set the release is done by moving the car up or down depending on the direction of the safety set.

One example of a bi-directional safety gear:
ASCENDING CAR OVERSPEED (ACO)

Traction elevators can overspeed in the up direction because the empty car typically weighs around 40% less than the counterweight. When overspeed occurs, the results can be serious. Various failure modes can develop on the elevator driving machine assembly such as failure of brake components, pins, shoes, links, and brake arms. Other failure modes may include the loss of friction coefficient when the brake surfaces get oily, or brake drum and lining overheating due to dragging. Also, the failure of machine components such as shafts or gears can cause the car or counterweight to be pulled into the overhead.

When such a failure occurs, the drive sheave starts rotating in a direction dictated by the hoistway masses. If the car load exceeds balanced load, the car will overspeed in the down direction until it reaches governor tripping speed. The safety gear will apply and safely slow the car to a stop.

However, if the car load is less than balanced load, the heavier counterweight will accelerate downward and the car will be accelerated upward. The counterweight will continue to accelerate downward until it strikes its pit buffer with nothing to limit its speed.

Code requirements provide protection against ascending car overspeed and/or collision of the elevator with the building overhead by requiring detection of ascending overspeed of the car and operation of an emergency brake. This type of protection would have detected the upward overspeed condition of the elevator in the scenario at the beginning of this article and saved the young mechanic some embarrassment along with the costly repairs to the elevator.

Ensuring successful overspeed detection requires redundancy so that no single specified fault will lead to an unsafe condition. Confirmation of this redundancy is also required. Once the detection means is activated, a manual reset of the detection means is required. On MRL elevators the use of a self resetting governor and running the car off of the safeties usually by means of the car top inspection operation will disengage the safety gear. Once the safeties are reset the machine space is accessed via the car top to manually reset the governor switch.

UNINTENDED CAR MOVEMENT (UCM)

Many of our readers may remember an unfortunate incident at an Ohio State University dormitory when 24 student football fans packed into a passenger elevator headed for a night of celebration. According to the report, when the elevator—doors still open—unexpectedly began to descend from the third floor, pinning the last passenger that entered the elevator between the top of the elevator transom and the third-floor hall sill as he tried to escape. The freshman suffered chest and abdominal injuries and died almost immediately of mechanical asphyxia (the inability to breathe due to external pressure on the chest). He was just 18 years of age.

Unintended Car Movement (UCM) is the movement of the car away from a landing with the hoistway door not locked and the car door not closed. This can be caused by failure of the machine, brake, control system, or other components. This protection is accomplished with the detection of the unintended movement of the car and the operation of an emergency brake. To ensure the safe functioning of the detection means, redundancy is required so that no single specified fault will lead to an unsafe condition. Once the detection means is activated, a manual reset of the detection means is necessary.

When the 1990 Canadian code was adopted, it had a requirement for a device to activate in the event of up-direction overspeed as well as the elevator leaving the floor with opened doors. To meet this code, one elevator company developed a traction sheave brake called the “Sheave Jammer,” held in the normal running position by a magnetic solenoid. When the solenoid is de-energized the springs extend forcing the carrier and frictional plate assembly against the rim of the traction sheave. If the traction sheave is rotating, the frictional plate will be forced sideways and heavy disc springs
will compress causing a braking force which stops the car.

Sheave brakes have been available and are used as emergency brakes. The major drawbacks of these designs are that they are very hard on other machine components and there is the potential to stop the sheave without stopping an ascending car (i.e., given enough momentum, the ropes could slip traction when the drive sheave is suddenly stopped). ASME A17.1 2.19.2.1 excludes rope and sheave traction failures from UCM requirements.

Example of a sheave brake:

The Rope Gripper consists of two components: a pump unit and a brake unit. The pump unit consists of a pump, valve, and control circuits that are used to open the brake unit and trigger its activation. The pump compresses the springs and opens the movable shoe on the brake unit to allow clearance for the elevator ropes and put the Rope Gripper into the ready position. The brake unit is the device that actually clamps the elevator ropes to stop elevator movement. It uses a combination of a hydraulic cylinder and springs to push a rotating shaft up a stationary power cam, which applies pressure to the elevator ropes. The brake unit also has a solenoid assembly that is used to hold the movable shoe in the ready (open) position, and it applies the movable shoe when a fault signal is received from the elevator controller. The Rope Gripper is opened hydraulically (with a pump and valve) but held open electrically. It is triggered by the loss of electricity (of the solenoid assembly) and activated mechanically by way of springs, rotating shaft, and power cam. The solenoid is used simply to hold the rope gripper in the ready position, not to open it.

Example of the Hollister-Whitney Rope Gripper:
Modern Machine-Room Less (MRL) Brakes

Elevator machines typically include a brake having a brake armature, which is the moving part of the brake and includes the brake arms and shoes. The shoes engage a rotor that rotates with the machine shaft to hold the machine and sheave position when the cab is at a selected landing. Typical metal rotors have a splined center that couples to a splined section of the machine shaft. The brake clamps around the flanged section to resist movement of the rotor.

The rotor slides along the splined section of the machine shaft as the brake clamps and releases the rotor. One issue of concern with such an arrangement with prior elevator machines is that noise produced by the elevator machine travels through the hoistway and may be heard by passengers in the elevator car. The elevator machine in the illustration below shows a non-metallic elevator brake hub that guides axial movement of the rotor along the shaft thereby eliminating the noise from the metal to metal contact to provide quieter operation.

Other manufacturers offer a machine room-less brake design that uses two brakes, one normal and one emergency, each capable of holding 125% of rated load. The two brakes act upon a single brake surface that is integral to the machine sheave in its design. One machine manufacturer utilizes a caliper type brake system that acts upon a disc surface. Both of these MRL machines are of a compact pancake design that allows them to be located inside the hoistway above the uppermost travel of the car. There are special requirements for the adjustment and maintenance of the MRL machine brakes due to the access and egress of the machine spaces. In fact it is commonplace on new construction applications when these MRL model, PM (permanent magnet) machines with caliper type disk brakes are used, the manufacturers recommend not adjusting these brakes due to the sensitive nature and very tight tolerances. These brakes are set up in the factory and tested to strict specifications and are recommended to be checked for wear only during the periodic maintenance of the machine brakes.

Machine room-less elevators having the machine typically mounted in the overhead of the hoistway, require a unique means of releasing the brake during a power loss to the building.

In the event of an entrapment during a power loss with a machine room-less elevator there are provisions to
drift the car up or down using either a cable type brake release or a battery backed emergency rescue board that will pulse a current to the brake coil. This allows the unbalanced load to slowly move the car to a safe evacuation landing and stop when the door zone is sensed by the controller. Due to the free wheeling characteristics of gearless machines, extreme caution should be taken when drifting cars with a brake release cable or any means. If the brake is not in good condition and adjustment, the car could quickly reach a velocity that cannot be stopped by releasing the cable. The manufacturer recommends slow, easy picks with the cable brake release to drift the car as close to a landing as possible to evacuate the passengers. To safely perform this method requires at least two people and a means of communication from the controller to the intended evacuation landing.

Throughout this article there have been a few examples of when an emergency brake could have helped avert either a tragedy or extensive damage to property. Since the changes to the code in early 2000 and the safeguards implemented to modern elevator braking systems, I am certain there have been fewer accidents related to this area. As a 28 year veteran in the elevator industry working in and around and relying on elevator brakes, I for one feel a sense of comfort knowing these newer emergency brake requirements have been included in the national and local codes.
SAFETY FIRST

One purpose of an elevator brake is to hold the car at a floor. While this is true, it is also somewhat misleading. Consider what actually occurred in a twenty story building that was being modernized in the late 1950s. The modernization was at the stage where the cab was being replaced at the lowest landing. The old cab had been removed, reducing the weight of the car. When a helper stepped onto the car the car began ascending, increasing speed as it went upward. When the counterweight landed, the car continued to travel upward from inertia. When the car stopped its upward travel the helper was thrown upward striking the crosshead. He suffered permanent injuries and was no longer able to work in the elevator industry. Was this a malfunction of the brake? No, the brake's function is to keep the brake pulley from turning which means the machine will not turn. The car moved upward without the machine turning because the hoist ropes had slid over the drive sheave. (Note: Had the brake spring tension been set too low the reason for the accident could have been that the brake pulley rotated through the brake shoes due to the overbalance.) When the weight on the car was reduced the traction relationship between the car and the counterweight was no longer as originally designed. The light car was “overhauled” by the counterweight that greatly exceeded the weight of the car. Had the workers added test weights prior to removing the cab this injury would never have occurred. Planning work before starting work can save a life.

When this wild ride occurred the brake was performing its function as intended while the hoist ropes lost traction with the drive sheave. Knowledge of the car-to-counterweight traction relationship and how brakes function is especially important to anyone using a temporary platform or performing cab modernization.

GEARLESS BRAKE SERVICE PROCEDURES

Each elevator maintenance provider has his own schedule and procedures for servicing specific equipment. Servicing a gearless machine brake requires a consideration of the potential for accidents to the mechanic and also to the riding public. During normal elevator operation, working around the brake presents multiple pinch hazards. As the brake releases or applies, clearances between stationary and moving parts change. See Figure 1. This is one of the reasons why the car must be removed from service before working on the brake. Checking the brake pulley to see if it is excessively hot

By Bill Guyer, Local 27 Retired
Rochester, NY
can result in burning the mechanic’s hand. Before working on the brake it is a good idea to watch the operation of the brake prior to removing the car from service. This inspection may determine the work necessary. Prior to working on the brake the car must be removed from automatic operation and the door operation prevented to protect the public from a possible accident. The Mechanic should ask the building management for permission to take the car out of service. Let them know that they will be informed when it is returned to service.

**Caution:** Some drum machines and a few traction units have cars heavier than the counterweight. The following procedure would not be used for them.

With the car removed from service at the top landing with the doors closed, the car can be slowly raised electrically until the counterweights land. Observe when the final limit switch opens by noting the car’s position when the safety circuit opens. Next, turn off the correct main line switch to remove power to the unit being serviced. Lock out and tag out the main line switch in accordance with company policy. Use a meter at the controller to verify that power has been completely removed from the correct unit. The brake can now be serviced safely.

**Caution: When the brake is disassembled be aware that there may be some slight rollback causing unexpected movement of the machine.**

Gearless machine brakes are commonly either the external or internal type as shown in Figure 1. Some newer Machine Room-Less (MRLs) gearless elevators use a disc type brake. They are covered in another article. Revolving type brakes were also used on gearless machine brakes but will not be covered in this article. ▶

![Gearless Brakes, Figure 1](image)
Begin disassembly by placing cardboard on the floor on each side of the machine to avoid introducing foreign particles into parts to be cleaned. Mark the brake cores to assure they are returned to the same side. Some mechanics use a prick punch and make a single mark on the brake core housing and a similar mark on the corresponding core. The opposite side receives two marks each. Since the cardboard is on both sides of the machine marking the cores may not be necessary. Remove the brake cores and their shims and place them on the respective cardboard. Clean the core liner and inspect it for wear or any rough surfaces. Correct by replacement or sanding lengthwise as needed. On horizontal brake cores rotate the core liner ¼ turn to avoid wearing out only the bottom of the liner due to core weight. (Note: Some brakes require lifting the brake coil to rotate the core liner. The core liner should be supported to reduce distortion.) Isolate the brake coil leads and check for grounds and damaged insulation. Clean the brake cores and shims. Remove any paint on the brake cores, shims or pins. The shims prevent the ends of the cores from striking each other. Various brake cores have used a brass plate, or a leather washer, or a brass or aluminum washer on an alignment pin to maintain an air gap between brake cores. Keeping the cores and shims on opposite sides of the machine reassembly retains previous settings. Check all parts for damage, inspect the cores for rough surfaces and correct. When brake core faces are serrated or stepped, inspect the edges for burrs. Prior to reassembly, the brake cores and liner will need to be lubricated. Lubrication may be grease, oil, petroleum jelly, and graphite or another method. Company policies vary on cleaning and lubricating procedures. Consult your Supervisor if you are unsure of their methods.

Check that the air groove slot in the core is aligned with the air hole in the core face cap. The air groove slot allows air to escape the core liner when the brake cores move. The slot also breaks up the magnetic field which reduces lifting and drop out times for the cores. Reassemble the brake ensuring that the brake core air holes are on top. Be sure all cotter pins and other parts are in their proper place.

The cores in Figure 2 have stepped mating surfaces that are designed for a special purpose. They can be controlled electrically to lift completely or partially. When the car is releveling to a floor after the brake has been applied, the cores are only partially energized. With this electrical setting the car drags through the brake but applies more quickly than if the brake had been fully lifted. During releveling this feature helps reduce overshooting the floor and “dancing” back and forth, trying to stop at the floor.

This partial lifting feature is also used when the elevator slows to stop at a floor. The brake coil current is reduced allowing the male and female cores to partially separate. Then when the car is electrically stopped at the floor the current to the cores is completely removed allowing them to separate quickly and completely. These partial separation features would not electrically work with cores having a flat face.
**BRAKE SHOES AND PIVOT PINS**

Next, measure and record the spring pressure by counting the threads on the brake spring rod end to the outer nut. This will allow reassembly with the same spring pressure. *(Caution: Avoid inhaling brake dust.)* Disassemble the brake shoes and inspect the brake lining. Wear should be even throughout the entire surface of the lining. The lining should be attached firmly to the brake shoe. Riveted linings must have the rivets recessed at least 1/8”. Linings should not be dark, which would indicate oil has penetrated the lining. When brake linings must be replaced be sure the new linings are not made of asbestos. While the brake shoes are off of the brake pulley, clean the brake pulley with a wiping cloth and a solvent that leaves no residue. A brake pulley with foreign material on it can cause a poor brake operation when lifting and dropping that cannot be overcome by adjustments. A dirty brake pulley can cause a “chirping” sound that can be corrected by proper cleaning of the brake pulley. If a “chirp” is heard when the brake lifts it may be due to an electrical adjustment that causes the brake to lift too slowly, sticky brake cores, binding pivot pins, or it may be just a dirty brake pulley.

Newer gearless brakes either require no brake pin lubrication or have fittings to add grease to the needle bearings. Older units typically used oil. Consult your Supervisor if in doubt. If older units have no oil holes, they could be drilled while the brake is disassembled. The lowest pins have little movement during normal operation and tend to be the first pins to *freeze up*. Inspect brake pivot pin bushings for wear and freedom of movement. Pins should move within the bushings or bearings so as not to wear out the casting. Frozen bushings or bearings will turn in the casting causing wear in the casting and not the bushings or bearings. Bushings and bearings are less expensive to replace than a casting.

It is a good practice to periodically lubricate and move the pins that have no pressure on them when the unit is out of service to keep them operating freely. Clean and lubricate all brake pivot pins. Inspect pins for evidence of rusting or galling, which has the effect of a cold weld. When stainless steel pins rust or gall it may be that the pin is not the correct hardness. Hardness is rated by its brinell number. When the stainless steel pin rusts or galls it may be due to using the incorrect brinell number stainless steel.

Inspect the wiring leading to the brake coil. These wires need to be protected from sharp edges on the cast iron brake frame. A grounded brake coil wire will not always blow a fuse. The brake coil resistor will drop the entire voltage supplied to the coil. The only evidence that there is a problem is that the brake will not lift and the brake coil resistor will be excessively warm. Some mechanics record brake voltages under various conditions in the job log to assist in future troubleshooting.

Examine the brake switch contacts and wiring for possible defects. If the contacts appear burnt, check to see if a capacitor is used across the brake contacts for arc suppression. The capacitor may be open. These contacts allow full power to the brake coil until the cores are almost fully picked. At this point the brake switch contacts open, inserting a resistor in series with the brake coil reducing the current through the brake coil. This reduces the heating of the brake coil and consumes less energy. The brake coil needs less ampere-turns of power to keep the brake lifted than it required to lift the brake.

Reassemble all brake parts. Inspect your work to ensure everything is in its place with no cotter pins missing. Remove dirty rags and cardboard to improve the work area.

**SETTING UP THE BRAKE**

Now that the required maintenance has been performed, final adjustments can be made. Restore power to the unit but leave the counterweight landed. Do not lower the car. Install jumpers to lift the brake temporarily. Use a feeler gauge to measure the clearance between the brake linings and the brake pulley. Do this at the top and bottom of each lining. The clearance should be equal and be between .003 and .006 inch. Consider the fact that if the...
brake linings rub the brake pulley while running, the pulley will heat and increase in diameter. As the brake pulley increases in size the clearance will decrease for an external brake and increase for an internal brake as shown in Figure 1. Make adjustments as needed to set the brake lining clearance. While the brake is being lifted, check the brake contact to see that it does not open until the brake is almost completely picked.

Prevent the doors from opening and return the car to the top landing. Remove the fuse that allows operation of signal controls, like lobby position indicators, to operate. Now when the car is run from the machine room by the mechanic the doors will not open nor will people viewing the lobby panel know that the car is operating. Operate the car on independent service while observing the brake operation. Be aware of all moving parts. Use a stethoscope or a screwdriver by placing one end on the brake shoe casting and the other end to your ear. Listen for any rubbing noise between the lining and the pulley. Some mechanics adjust the brake shoe lift by decreasing the clearance until a rubbing noise is heard and then slightly increasing the lift.

GEARLESS BRAKE TESTING

When any part of the brake, such as linings or springs, that affect holding or decelerating capacity are changed or adjusted, the brake must be retested per ASME A17.1 Section 8.6.4.6.2 using 125% or more of capacity. See Figure 3 chart. This is the test normally performed during a Category-5 test under ASME A17.1 Section 8.11.2.3.4.

Requirement 8.11.2.3.4 Braking System: For passenger elevators and all freight elevators, the brake shall be tested for compliance with applicable requirements. Test that the car can hold 125% load by placing it on the car at the lowest landing. With less than full load on the car move some weights to the floor above. Again, with the car one landing above the lowest landing place the load

<table>
<thead>
<tr>
<th>Class of Service</th>
<th>Not Permitted to Carry Passengers</th>
<th>Permitted to Carry Passengers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>Not applicable</td>
<td>125% rated load</td>
</tr>
<tr>
<td>Class A</td>
<td>Rated load</td>
<td>125% rated load</td>
</tr>
<tr>
<td>Class B</td>
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<td>125% rated load</td>
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<tr>
<td>Class C1</td>
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<td>125% rated load</td>
</tr>
<tr>
<td>Class C2</td>
<td>Up to 150% Rated load</td>
<td>Up to 150% rated load</td>
</tr>
<tr>
<td>Class C3</td>
<td>Rated load</td>
<td>125% rated load</td>
</tr>
<tr>
<td>One Piece Load by 2.16.7</td>
<td>Rated load or one piece load, whichever is greater</td>
<td>125% rated load or one piece load, whichever is greater</td>
</tr>
</tbody>
</table>

**FIGURE 3**

**TABLE 8.11.2.3.4**

**BRAKE TEST LOADS**
as shown in Table 8.11.2.3.4 in the car and run it to the lowest landing by normal operating means. The driving machine shall safely lower, stop, and hold the car with this load. Freight elevators of class C-2 loading shall sustain and level the car.

An additional testing feature not included in the above code requirement is to remove power to the machine while parked at the lowest landing. Check sleeve machine bearings for proper oil level. While jumping up and down in the car, the car should remain at the floor. Why did the power have to be off for this test? Because the standing motor field and armature current may help hold the armature from turning. During a power failure the brake by itself must provide the stopping force. Checking the oil level was done for the same reason. The test is to assure the brake can perform its function, independent of a dry bearing. Newer technology elevators are capable of holding the car at the floor even with the brake stuck in the lifted position.

Use caution when performing this test if new brake shoes have been installed. New brake linings may have a higher or lower coefficient of friction requiring more or less spring tension. The car may unexpectedly move as the load is being placed on it. This can occur at even less than full load.

**CLOSE CALL**

An elevator mechanic answering a trouble call for poor leveling got more than he bargained for. After riding the car, the mechanic realized that the car was stopping at the floor, then drifting upward away from the floor, then releveling back to the floor. When he entered the machine room he heard a loud metal-to-metal noise coming from the machine. His initial response was to pull the mainline disconnect switch. At this time the car was at the mid-point of the hoistway. This disconnected the very circuitry that was keeping the car releveling back to the floor. This elevator was designed to stop electrically at the floor and then have the brake applied to hold the car at the floor for loading and unloading. The brake linings for this elevator were completely worn away allowing the cast iron brake arms to grip the brake pulley in a most inadequate way. Since the brake could no longer grip the brake pulley, the car began to ascend, gaining speed as it went, with nothing to stop the car except having the counterweight land. Once the governor tripping speed was reached the governor switch and then the jaws tripped. This did nothing to slow the car in the up direction. When the counterweight landed the car continued to ascend from inertia. The hoist ropes became slack until the car stopped traveling upward. The slack hoist ropes allowed the car to move downward until the car safeties set with the car in the overhead.

To correct this situation a repair team was dispatched to reline the brake after replacing the brake pulley that was no longer usable. The repair crew had to use a chain fall to raise the car to release the car safeties. Prior to returning the car to service a 125% rated load test of the braking system was required according to ASME A17.1 section 8.11.2.3.4.

The failure to recognize the wear of the brake shoes or a condition that caused their rapid wear turned this into an expensive repair job. A proper inspection on a periodic schedule could have prevented the potential for injuries. Fortunately, no injuries occurred, this time.

Bill Guyer
Rope brakes or grippers were originally designed to activate during Unintended Car Movement (UCM). UCM is the unintended movement of the elevator away from a landing with the doors open. Another requirement of the rope brake is its application in the event of an ascending car overspeed (ACO) condition. Ascending car over speed occurs during an up travel beyond the governor electrical tripping speed. Any other interruption of the safety circuit or loss of power will also result in the application of the gripper, which is of a fail-safe design. The rope brake also protects against other catastrophic failures such as the failure of a machine drive shaft, the failure of a machine gear set, or the loss of traction of the hoist ropes. Section 2.19 of the ASME A-17.1 – 2007 / CSA B-44-07 states the conditions for which a secondary brake is required.

There are two main types of rope brakes used in our industry. The pneumatic type relies on air pressure to hold the brake pads open, creating spring tension, and the hydraulic type uses an oil medium to lift the pads and compress the springs. In both cases, the brake pads are applied under spring force to grip the hoist ropes creating the required braking action. Regardless of the type of rope brake being used, similar components such as switches, springs, linkages and semi-metallic brake pads appear in their design. The most common rope brake currently used in our industry is manufactured by Hollister-Whitney, which is a hydraulically operated
These units are rated or sized based on duty and speed of the elevator on which they are to be installed.

When the logic control is ready to operate and the rope brake is in a ‘safe to operate state’, a signal is sent to the rope brake to lift the brake pads. The hydraulic pump motor energizes lifting the brake pads via a cam traveling along the contoured shape of the frame. Full travel of the cam activates a micro switch which disconnects the pump motor. Now the springs are compressed and the system is latched electro-mechanically.

When the rope brake is to be applied, power is removed from the system releasing the activating cam. The spring force takes over, applying the pads to create the necessary gripping action on the hoist ropes. The logic control is designed to identify faults defined by unintended car movement (UCM) and ascending car over speed (ACO). Typically when the car is landed at a floor with doors open the door zone signal would be high, door open limit low, door and gate switch low and door close limit high.

Should the controller detect a state change of these signals (i.e. loss of door zone with door close limit high and no run demand) then the logic circuit would open dropping the gripper. This would be referred to as a low speed trip or a UCM occurrence. Ascending car overspeed signaling is typically accomplished by opening a governor overspeed switch. In the worst case situation of a complete loss of traction due to an imbalance
condition the only thing that would stop and hold the car would be a rope brake. If this condition were to occur on a unit equipped only with a drive machine brake, the sheave may stop rotating; however, the ropes would still travel over the sheave. Also, as a critical component to the elevator system, the rope brake must signal the logic control to remove power from the driving motor as required by code.

Basic maintenance is required in the form of regular hydraulic oil level checks and checks of the integrity of the fittings. Should oil be required, it must be SAE 30 non-detergent, as detergents will cause premature pump failure by destroying the seals. The unit is equipped with a power toggle switch that can be used to check the activation and reset (lifting action) of the cam and pad assembly. As a safety pre-caution, care must be taken as the system is under stored energy from the compressed springs. If the latching assembly is not correctly adjusted, the pad assembly will be held open by the hydraulic pressure causing the pump unit to run continuously. In order to prevent this from occurring, the manufacturer has installed adjustable actuators. When properly adjusted the mechanical latch will make and the actuator will
break the micro-switch contact shutting off the pump unit. The mechanical latch assembly must be kept clean and lightly lubricated since this is the mechanism that arms the system. An improperly adjusted actuator will reduce the life-span of the unit as a result of overheating from continuous duty. It is advisable to lubricate the cam and latching assembly to prevent binding in both open and closed positions. Also, an ‘excessive wear’ micro-switch (worn pad micro-switch) is provided. This switch is activated by the cam’s length of travel and is a pre-determined factory setting. It does not prevent the mechanical application of the system, but prevents the unit from being energized, after having monitored excessive pad wear. Should this occur and the pads require replacement, both pads must be replaced together to ensure proper burn-in. The unit is equipped with a manual pump and in the event of a loss of power, the rope brake will be applied. Under these conditions the only method of lifting the rope brake is by use of the manual pump.

To manually lift the cam assembly, turn the auto/manual switch located in the top of the pump unit to the manual position and pump up the cam assembly using the provided small hand pump. Once in the lifted position, two set screws located in the body of the jack unit, can be run in to hold the cam in the lifted position.

It is imperative that the manufacturer’s specifications be observed during pad ‘burn-in’ as they have a direct effect on the braking performance of the unit. The “burn in” process shapes the pads to provide the required gripping action. Since new pads are flat sufficient gripping action to stop the car may not be provided. By shaping the pads, the contact surface area is increased providing the required gripping action.

A requirement for secondary braking protection resulted in the introduction of the rope brake to the elevator industry. The protection for UCM, ACO, machine component failure, and a loss of traction condition has resulted in an increased level of safety in our industry. On March 29, 2005, in London, Ontario, we lost an IUEC brother when a unit he was operating suffered a catastrophic loss of traction due to an imbalanced condition. This tragedy could have been avoided if the unit had been equipped with a rope brake. Units being installed today with rope brakes provide elevator constructors and the general public with an increased level of safety.
Adjusting Geared Brakes

By Bob Hess, Local 17 Retired
Cleveland, OH

Working in the elevator business for an independent company in the early 1960s afforded the opportunity to reline, repair, and adjust many different styles of brakes. They ranged from a leather lined sheet metal strap roughly shaped around a brake pulley, to the more modern shoe type with Raybestos linings. Raybestos is a brand name of a product used for brake linings by major elevator manufacturers still used today. The company name implies that asbestos was used in the manufacture and this was true of the early brake linings, but modern brakes contain no asbestos.

Hundreds of various styles of brakes have been used in the elevator industry, which makes it seem like a nightmare to learn the operation and adjustment of each one of them. Although many brakes have their quirks in repair and adjustment, most brake adjustments are basically the same in theory. The plunger should be adjusted for minimum travel. This means that the shoes must fit the drum well and no lost motion in the system. The brake shoes should be adjusted for minimum clearance to the drum. This will help ensure that there is no wasted travel of the plunger and that it can operate well in both the pick up and drop out conditions. The spring pressure should be adjusted so that the brake holds the required load. It should not be so tight that its operation becomes marginal in cold conditions or low voltage situations. The means to accomplish these items can vary considerably.
One particular brake has a master shoe that is adjusted first and a slave shoe that is adjusted second. Some brakes have a vertical solenoid to release the brake, others have a horizontal solenoid with one or two plungers. The vertically operated plunger brings to mind the older style Haughton brake, which some people look at and say it can’t work. This brake does not have a stopping force adjustment. It depends only on gravity and the weight of the core for stopping power. I saw one of these brakes that someone had added weight to the pick-up arm thinking this would stop the car more quickly. However, he added so much weight that the brake wouldn’t release. So instead of removing weight, he added a spring to help the solenoid release. Manufacturers’ procedures should be followed closely for adjusting this type of brake.

The correct way to adjust this style of Haughton brake is to first set the stroke then adjust the shoe closest to the solenoid, then adjust the opposite shoe. The spring on the horizontal brake arm coupling rod will set the stroke, not the stopping power of the brake. The spring is adjusted until the horizontal arm to the solenoid is level. The brake should be completely set on the drum just before the plunger is landed. There should always be free play in the washer behind the master-shoe-stop when set. Adjusting the air check on the bottom of the solenoid housing prevents the plunger from bouncing. I was frequently called to repair the Otis “L” brake which is also an AC brake submerged in oil. A common problem with this brake is the AC suppressor, which can break or come loose causing a loud 60 cycle growl. A common belief is that the oil is used to cool the brake.

Old Style Haughton Brake
ADJUSTING GEARED BRAKES

The real reason for the oil is to cushion the brake stroke, which prevents destroying the laminations on the magnetic cores. Some of these brakes have an adjustment for this. Oil can seep out over the years and should be regularly checked.

Some elevators that level through a partially picked up brake make proper adjustments even more critical. The brake shoe clearance should be kept to a minimum. Be sure that the brake contact doesn’t open before the brake is fully released and be sure that the brake pulley is clean. Contaminated brake pulleys can easily be overlooked. A brake pulley can get contaminated from gear oil, motor bearing oil, cable lube, and cable dust which can cause brake shoes to be sticky or slippery. A sticky brake will cause the brake shoes to stick to the pulley creating a very abrupt start. During a re-level this can cause the car to move abruptly with the doors open. A slippery brake can affect the floor accuracy especially on a single and a two speed AC control.

Single speed AC Elevators rely completely on the brake to stop close to the floor. This brake needs to be adjusted to minimum clearance stroke and proper spring tension. The minimum clearance of the brake shoes is usually set with a feeler gauge at approximately five thousandths of an inch. The stroke of the plunger (solenoïd) should be adjusted to the shortest travel that still releases the brake shoes. On most modern machines the travel required to lift the shoes from the drum will determine the brake stroke. This is what makes the fit of the shoe to the drum so important. The spring should be set to stop and hold the car with a capacity load plus 25 percent. Two speed AC elevators level a little better than single speed; however, they still rely on the brake to stop close to the floor. The slow speed of two speed motors is a ratio of 1:2 or 1:3. A two speed AC elevator’s slow speed is this ratio of its high speed. On a 1:3 motor the leveling speed of a 150ft/min car would be 50ft/min. This is a leveling speed much slower than a single speed but not nearly as slow as the typical 6ft/min leveling speed of a DC or variable speed AC motor. Brakes used on two speed motors should be adjusted using the same method as those on single speed. Springs must be set to hold 125% load and not the stopping position of the car.

Watch for older elevators that originally had leather or other composition brakes shoes that have been changed to a different material. These brakes have been altered from their original design and may not function properly during a 125% brake test. When performing a 125% brake test, we should assume the brake on any elevator may be completely maladjusted by well intentioned adjustments over the years. Exercise caution when loading weights on to the car. Assume that it may move before full load is reached.

Another frequently overlooked problem is elevator cabs being upgraded cosmetically, such as suspended panels, new ceilings, mirrored walls and new flooring. Adding
as little as 300 lbs. equals the weight of two passengers. I have seen cars with as much as 1000 lbs. added. These cars are subject to losing traction (the cables slipping on the driver) when the car slows down with a capacity load. The added cab weight and a capacity load can easily exceed 125 percent. Any weight added to the car after the 125 percent test has been completed adversely affects the outcome. Notify your office if you think a rebalance of the car is needed. Any moving parts of a brake assembly should be properly lubricated according to the manufacturer’s recommended procedures including brake cores and plungers.

The method of adjusting brakes varies by manufacturer. Older Otis elevators used an AC brake submerged in oil. The oil was used to cushion the stroke to prevent destroying the laminations. Continually hammering the laminations will eventually cause them to collapse and loosen, which will eventually eliminate the air gap that is required to eliminate the possibility of residual magnetism. This brake also has a copper suppressor around the coil to prevent the 60 cycle hum, if you experience one of these brakes that make a terrible growling noise when energized you may find the copper suppressor is cracked or the screws holding the suppressor have come loose. Working on older brakes is a challenge. What may seem simple in their operation can be far more complicated than it appears. Take time to learn about proper maintenance and adjustment procedures before performing service and adjustments on them.

Alternating Current Brake
Elevator Brakes have not changed much since they were introduced on the first elevators. They are all designed to electrically pick and mechanically set. From the beginning, they were mostly built on an external drum design. Over the years, brakes have gone from band style to internal and external drum types. Disc brakes can be caliper type, full friction disc type, or even disc brakes where application force comes from permanent magnets.

They all have combinations of plungers, springs, fulcrums, arms, shoes or pads and pivot pins, all of which must be in good working order to operate properly. Though the design, application and adjustments vary from one company to another, the basic principle of operation is the same, to provide an apparatus that will stop and hold the elevator.
at the floor while the car is being loaded or unloaded. Unlike the brakes of an automobile, the brakes of an elevator are not normally used to slow the elevator down to land at a floor. They are designed to hold an elevator at a floor while loading and unloading and provide a means of stopping the elevator within a safe distance should there be an emergency stop due to a clipped interlock, stop switch or safety circuit activation or loss of power. A variety of circuits, contacts, resistors and rectifiers provide different adjustment methods for releasing and setting the brake smoothly.

For optimum and safe performance of the brake, all parts must move freely and with little or no friction. Plungers must be adjusted for minimal travel or manufacturer's specifications. To obtain minimum plunger travel brake shoes must be adjusted for minimal clearance to the drum or disc when released and with maximum surface contact when applied. Springs must be adjusted, per ANSI A17.1 code, to stop and hold a minimum load of 125% of the capacity of the elevator. Brake coil circuits must be adjusted with enough current to provide a reliable, smooth and quiet picking operation. A brake should reach fully picked position within approximately 1 second depending on machine and control type. The brake should also be adjusted to set smoothly by controlling the speed that it sets to the drum or disc. Brake electrical adjustments should not be performed before it is verified that all parts operate with little friction and lost motion. With these adjustments set properly you will have a smooth and quiet operating brake. A brake that slams or bangs open or closed is not adjusted properly and is in need of maintenance or repair.

While most brake solenoids and lever arm assemblies are rigidly connected to the top of the machine or on framework to the bedplate, one unusual design is not. The venerable design of this brake did not lock the position of the solenoid and lever arms at the top. The top of the device is free to float within an area defined by the stop adjustments at the bottom of the shoes. When the brake is energized the top of the shoes are pushed apart against their springs. If the bottom stops were relaxed the entire coil and lever arm assembly is free to rock back and forth until the shoes contacted opposite sides of the brake drum depending on the stroke at the plunger. Proper setting of the plunger stroke and the stops at the bottom of the brake arms assures correct shoe to drum clearance and centering of the shoes equally away from the drum.

Brake solenoids, plungers, and other related brake hardware are usually in the open and very accessible. This unusually designed brake had solenoid coils that were enclosed in the brake arms. When you first see this machine you may think that there are some drastically needed parts missing. It appears to have no solenoid or levers to release the brake shoes. Even upon close inspection only a glimpse of the solenoids can be seen behind the brake shoes.

One unusual type of brake is the permanent magnet disc brake. It is used in some moving stairway installations. This variety is a clutch type design. The installation, set up and adjustment of this type of brake is crucial to its operation in that the brake relies solely on the free movement of the disc and strength of the magnet to set the brake. To
release this type of brake, a coil is wound around the permanent magnet and voltage is applied to nullify or offset the magnetic strength of the permanent magnet to allow the disc to release.

Another odd and old machine is the Otis Micro-Drive. There are those among us who may see this as a thing of beauty….a work of art. There are also those that may say “What the ….were they thinking?” To appreciate the practicality of this machine you need to look at what was available in the 1920s. AC machines were far slower and less costly than DC machines but their lower speed was just fine in low rise buildings. The only problem was that they didn’t level well at all because they couldn’t slow down enough for an accurate floor stop.

The Micro Drive system solved this dilemma by using two machines to run the car. The first and larger machine and motor was capable of running the car at up to 300 ft/min and a smaller machine that took over the leveling operation ran the car at a very reasonable 20 ft/min that provided an accurate stop at floor level. Rather than try to slow the large AC motor, the leveling operation shifted over to a smaller machine with a lower gear ratio and speed for leveling. When the motors of this machine were AC they were constant speed but the gear ratios of the machines provided respectable high speed running and low speed leveling operation. The trick to this operation was to be able to engage the low speed machine for leveling and disengage it for high speed runs. This feat is accomplished by a coupling between the output shaft of the leveling machine and the motor shaft of the large machine. This device looks much like a standard drum brake that has broken loose from the bedplate because the whole device spins wildly, shoes and all, when it is in leveling speed. To see this machine in action you immediately can see why it has accurately been called the widow maker. You would never expect to see this substantial mass of iron arms, shoes and springs spinning at this high rate of speed. Many of the guards intended to prevent accidental contact have been lost or discarded over the last 90 years and the high visibly is a scary sight.

Some of the Micro-Drive machines also have a separate torque motor to open the main brake or coupling rather than a coil. The torque motor rotates to push a lever that in turn pushes a rod through the leveling machine gear box to open the main brake or coupling on the other side. Once the main brake is open, the main drive motor runs the car at full speed. When the elevator gets to the point where leveling speed takes over, the torque motor releases the main brake that couples the main motor shaft to the gearcase shaft of the leveling machine. Once coupled the entire main brake and drum assembly rotate the main machine motor until the car arrives at floor level. The smaller leveling machine brake then sets to hold the car at the floor.

This machine is also beyond a doubt a candidate for the Elevator Hall of Fame. You’ll be able to tell your grandchildren about it for years to come. You can also see it as an example of how the industry has adapted to meet the needs of an era. How many modern machines will still be in service 90 years from now?
BRAKES ON GEARLESS ELEVATORS

At a hotel just west of Chicago a bellman stood at his station in the lobby watching passengers exit an elevator. He noticed the car releveling as the people were disembarking. After the last person left the car the elevator began moving up the hoistway with the doors still open. As the car door clutch released the hatch door rollers, the hatch doors slammed shut. The car continued accelerating up the shaft until the counterweights slammed into the buffers. The inertia of the car carried it into the bottom of the machine room floor destroying the car top roller guides, leveling units, and anything else above the crosshead. The sudden stop also set the safeties, wedging the car at the top of the hoistway. Thank goodness no one was in the car! What the heck happened?

Investigation of the incident found that the brake linings on the machine were worn down so badly that the brakes could no longer hold the car at rest. Apparently the brake had not been picking properly and the brake drum ground the linings down until they could no longer grip the drum when the car stopped. The car attempted to level at that floor until it faulted out and set the brake as it was designed to do. All traction elevators are designed like this; if motion control is removed the brake is set. Only this brake was not able to do its job, to hold the car.

The lifting and application of brakes is at the top of the most significant factors directly affecting passenger safety. While elevators can amble along with minor problems and less than ideal ride quality, a car with a brake that is not able to hold a full load can cause a devastating problem. The adjustment and maintenance of gearless brakes is exceptionally crucial. A gearless machine by its nature has more direct effect on car position than a geared machine because of the direct relationship of the drum movement to the position of the car. The drum surface moves ½ inch, the car moves ½ inch. A ½ inch movement on a brake drum surface on a geared machine (because of the gear ratio) will be negligible on the car.

Maintenance of elevator brakes follows along similar lines from company to company. Various company maintenance programs support necessary, periodic brake inspection. Much of the inspection process involves just the observation of the brake operation, but a deeper look may require disassembly of parts of the brake mechanism. So before we address any type of brake work we must identify and implement the safety procedures for the job at hand. Follow the accepted lockout/tag out procedures. Other concerns include but are not limited to awareness of moving equipment, pinch points, and...
stored energy. Make sure the car and hoistway doors are closed and locked; barricades at the top floor will also help deter unauthorized personnel from going near the hoistway while the brake work is proceeding. Again you must adhere to your company's safety policies.

Besides all the issues listed above, with brakes we have other safety concerns. First, the counterweights must be landed before any type of disassembly. This step addresses two safety issues: it verifies that the counterweights are heavier than the car by the action of drifting the car up, and it relieves the stored energy that is being exerted on the brakes by the car. Second, it is a good idea to disable sheave movement directly with blocks and/or clamps to prevent unintended movement of the car with the brakes off. An unauthorized person opening the doors and either getting on the car or placing something on the car could prove catastrophic.

Brake-specific safety concerns also include close inspection of the brake pivot pins. They must be free to rotate and be well lubricated. (The old Otis mechanics claimed they used to turn every pin a quarter turn every week as part of maintenance.) If there is any sign of rust, the pins should be removed, cleaned, lubricated, and reinstalled. The pins should have little or no slop; however, they should pivot freely. In some cases the pins and bushings are so badly worn that they have to be replaced.

Plunger movement, typified by a short stroke, requires special attention. Contaminants, wear patterns, galling, and dried lubricants can greatly affect smooth operation during pick and drop. I’ve seen grease, oil, petroleum jelly, graphite, and molly film used on plungers successfully. Use whatever is recommended by the manufacturer or your company's preference. Be sure to use thin coats, as excess lubricant could drip onto the brake drum. The drum is usually under the plunger that's being lubricated (Note: The use of grease or oil on geared machine brake plungers, in my experience, seems not to be a good idea. Due to the heat that many small brake coils generate, the lubricants seem to dry up quickly and can cause pick and drop problems. I've seen write ups from at least two manufacturers that recommend dry lubes, like graphite or molly film). New lubricants such as graphite paint (dries hard, reduces dust) and synthetics show great promise. Check with your company before use.

Another concern is the brake lining. The lining must contact the drum completely when set to ensure consistent holding capacity. If the linings are worn irregularly or worn enough that rivets are near touching the drum, they must be replaced. Contaminants including dirt, lubricants, rust, etc., will affect holding power and must be addressed.

With these safety issues addressed, we are ready to consider adjustment of the brake pick and drop. Normal brake operation on modern elevators means the brake must hold the car only after the controls stop the elevator automatically, and must occasionally stop the car on inspection runs. The linings on these cars should last indefinitely.

Gearless brakes present their own unique set of challenges during adjustment. I like to make sure the machine is at operating temperature before the final adjustments as the drum will expand as the machine heats up. Therefore, I start with larger initial air gaps between the drum and the shoe linings to enable us to run the car in a controlled way. With the doors disabled and no passengers aboard, bring the car to operating temperature without the shoes dragging and causing
the drum to overheat. The ideal time to start this procedure is first thing in the morning, as gearless brakes require a lot of monitoring during and after initial adjustments.

A time honored way to adjust brakes involves running the car and listening for sounds and feeling for vibrations on the back of the brake shoe away from the drum and the brake housing. I understand that some company safety policies prohibit being around moving machinery and so be it. If you are constrained by such policies you will have to use feeler gauges and try to find high spots on out of round drums as best you can. If you can listen for noises on rotating drums, be sure you adhere to some common sense safety practices. Before you move the car set yourself in position and clear of any moving objects on the car you’re working and any nearby cars which are in service. Do not change position until the car has stopped. I find that listening for ticking and rubbing noise and feeling for vibrations, while adjusting pick and toe in and out (the clearance from the drum at the top and bottom of the shoe) produces the best result. The idea as always is to get clear running shoes with minimum plunger movement. Because of their mass, gearless brake drums can start to warm slowly but heat quickly once they start expanding toward the shoes. Use of an inexpensive heat sensor gun can help detect this temperature rise quickly. Your fingertips are not as sensitive to temperature change, and the sensor gun could prevent you from getting a blister! Been there done that!

A few years ago an associate was running an old Otis 74 machine for cutting purposes, cables off, with a belt driven motor. He had wedged the brake open, but not completely. The drum was dragging slightly. He periodically checked the drum with his finger tips until the last time, when the heat had made the drum tacky enough to stick to his finger tips and pull them into a shoe. He lost parts of two of his fingers, partial usage of another two and was off work for quite a while. This incident was clearly a violation of good safety practice. Never touch a moving drum no matter how slowly it is moving. It was an accident caused by a moment of bad judgment. It is included as an example of what NOT to do.

The adjustment also includes the smooth drop or set of the shoes. Achieving the shortest plunger movement while keeping the shoes running clear of the drum is the goal. A short stroke puts the plungers closer together allowing them to pick/energize quicker and drop the shoes more quietly and with minimal notice of the stop by the passengers. The most common approach to dissipating the EMF of a brake coil and trying to control the drop is to use parallel resistors. The smaller the parallel resistance, the longer the drop—to a point. The larger the parallel resistance, the quicker the drop. The use of low resistance parallel resistors to achieve a slower drop created a slower pick by bleeding off current from the brake coil until wiring a diode in reverse bias to the parallel resistor came into common use. This practice allows full current to the brake coil during pick and a quicker and more controlled set of the brake.

It bears mentioning that when we do any repairs involving the removal or take down and re-installation of brakes that we need to test its holding capacity before the car is returned to the riding public. The practice of counting turns on the spring compression nuts and returning them to the same position is not as accurate as actually checking the capacity with test weights. One face turn (1/6 of a turn) one way or another on a large nut on a gearless brake can make a big difference in performance, both in holding capacity and/or running clearance. A spring cranked too tight can cause a brake not to pick completely and/or brake arms to twist or bend changing clearance.

Anytime brakes are disassembled a capacity check is in order. The different composition of new type brake linings also dictates capacity checks upon installation. Brakes have to hold the load every time they set. not just every five years. The all too common practice of building owners having unqualified contractors remodel cabs
has become a big factor in affecting elevator capacity. Adding paneling, mirrors, bronze, marble floors, diamond plates, etc. without regards for counterbalance and machine shaft and bearing loads is very risky.

The company I work for took over maintenance of 13 elevators in a 39 story building recently. It was soon obvious that an oil leak contaminating the brake drum on one of the low rise cars was also causing the friction drive motor encoder to slip. To repair the bearing the “clam shell brakes” on the old Otis 74 machine had to be removed. The brakes and drum were completely cleaned and reinstalled. When we began to check for 125% load on the 2500lb. capacity car, the car sunk into the pit with just under 2000lb. on the car. No amount of spring adjustment could get the car to hold the required 3125lb.. On several tries I had the springs so tight that the brakes would not even pick completely. Even new linings didn't work. It turns out the customer had remodeled the cab, adding a marble floor, paneling, bronze, and mirrors. The counterweights are full and replacing weights with lead is costly, along with the added weight on the shaft & bearings. If the company did this without an engineering ok, they could incur responsibility for damage to the machine bearings, shaft, and possible building structure damage, should it occur. With very limited options available the car capacity was reduced to compensate for the additional cab weight and allow the brake to hold 125% of that capacity at rest.

Over ten years ago we took over maintenance of a duplex in a condominium. The 5 year tests came up shortly afterward. The service team began loading the test weights and with only half of the weights on the car, it slid into the pit. They had to unload part of the weight to even get the car back up. Figuring a problem with just that car, they tried the other car with the exact same result. When I got there we began to check counterbalance. We achieved balance load with the helper and two 50lb. weights on either car, indicating that the counterweights were between 78% and 82% short of the proper weight to ensure good traction and rated lift capacity. A visual inspection confirmed that the counterweight frames were only 1/2 full. It turned out that the original general contractor had gone bankrupt and the original elevator contractor had never been allowed to finish the installation. The building had been occupied for over ten years, which meant an installation inspection and at least two five year tests should have been conducted. We never found out who did them or how they might have been conducted. When taking over elevator installations on maintenance a check of proper counterbalance and brake operation is always a good idea during the pre-maintenance work.

We sometimes might not give brakes the attention we should because they usually work so well. There is a lot of talk about and usage of redundant systems on modern elevators to protect the riding public better than ever before. But if you think about it, brakes could be considered the original and most effective backup system we have on traction elevators. When the controls fail or the system faults out, the brake drops and holds the car, keeping our passengers safe.
THE NATIONAL ELEVATOR INDUSTRY EDUCATIONAL PROGRAM (NEIEP) and IVY TECH
COMMUNITY COLLEGE OF INDIANA (IVYTECH) have joined in partnership to enable the
delivery of associate of science and associate of applied science degrees to apprentices
enrolled in the National Elevator Industry Educational Program of the International Union
of Elevator Constructors.

THE INNOVATIVE SYSTEM will allow apprentices enrolled in local Joint Apprenticeship
Programs the opportunity to attain an associate degree by enrolling in Internet-delivered
general education courses leading to a degree. This program has also been articulated with
the National Labor College (NLC) to pave the way for those students wishing to pursue a
bachelor’s degree.

IVY TECH COMMUNITY COLLEGE OF INDIANA is a public, statewide, open-access,
community-based college.

Since its establishment in 1963, Ivy Tech has fulfilled its dual mission: to enable individuals
to develop their fullest potential and to support economic development in Indiana. Ivy Tech
is accredited by the North Central Association of Colleges and Schools and has been
working with the building trades programs for a number of years. In 1993-94, Ivy Tech
developed an associate of applied science degree program that is approved and monitored
by the Indiana Commission for Higher Education. THIS IS A WORKING PARTNERSHIP
WITH EACH JATC PROVIDING THE TECHNICAL EDUCATION COMPONENT, AND IVY
TECH PROVIDING THE GENERAL EDUCATION FOR THE ACADEMIC COURSES OF THE
DEGREE. This joining together of education and training expertise provides for the delivery
of a uniform associate of applied science degree. Ivy Tech is currently working with building
trade apprentices in different trades across the nation.

IT IS OUR GOAL TO PROVIDE EVERY APPRENTICE WITH THE OPPORTUNITY TO EARN A
JOURNEYMAN’S CARD AND AN ASSOCIATE OF APPLIED SCIENCE DEGREE DURING
THEIR APPRENTICESHIP INDENTURE.

THE NEIEP - IVY TECH AGREEMENT provides NEIEP graduates the opportunity to address
the ever-changing needs of the elevator industry workplace in the future. The agreement
enables all local NEIEP programs across the country to participate actively in this educational
initiative. The program is open to all JATCs within the NEIEP system.

OPERATING PRINCIPLES
• NEIEP partners with Ivy Tech Community College of Indiana for AAS / AS degree program
• NEIEP and Ivy Tech partner with the National Labor College for BA or BTPS program
• Leverages the educational components and the technical program skill development in
  the traditional apprenticeship programs
• Adds general educational courses to technical core to complete a well-rounded program

CONTACT INFORMATION:
Mary Montgomery
Ivy Tech Community College of Indiana
50 West Fall Creek Parkway North Drive
Indianapolis, IN 46208
mmontgom@ivytech.edu; phone: 317-921-4865; fax: 317-925-6001